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US Department of Transportation
Federal Aviation Administration
Office of Aviation Policy and Plans
Washington, D.C. 20590

Minimum General Aviation Airport and Airway System Requirements

FAA-APO-81-4

September 1977

Dr. A.N. Sinha

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16. Abstract

This report forms a part (Volume V) of the Airport and Airway Costs and User Cost Responsibility Study for 1977-1986 time frame. Because the existing ATC system provides services far beyond the minimum requirements of the general aviation (GA) community, there appeared to be a need for providing a lower bound on the GA cost responsibility. The analysis presented here develops a hypothesized GA-only system based on ATC requirements of the GA user group (including air taxi and business jets), and estimates the associated costs of the postulated system for the ten-year study period.

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SUMMARY

The hypothesized GA-only system is designed to meet the minimum requirements of the GA community (including air taxi and business jet operations). The cost of the postulated system grows from $331 million in 1977 to $400 million by 1986 in constant FY76 dollars. In current dollars the 1977 cost is estimated at $356 million increasing to $703 million in 1986. Cost sensitivity of the minimum system to questions of coverage and demands for service is rather small (less than 5%).

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1. INTRODUCTION

The existing Air Traffic Control (ATC) system provides services to air carriers, general aviation, and military users of the controlled airspace of the civil aviation sector. A common ATC system has an inherent cost advantage over separate systems to provide similar services for each user because of the commonality of joint use elements. However, the common system must be designed to meet the requirements of the most sophisticated class of users, namely air carriers. Consequently, the nature of services provided to other users of the system often exceed their individual needs. Thus any cost allocation scheme of user responsibilities based on the existing ATC system, although satisfying economic criteria, may assign higher costs to the less sophisticated users than would be experienced if service was limited to that required under a separate system scenario.

As part of the overall study of Airport and Airway User Cost Responsibility 1977-1986 (Reference 1), it is desirable to assess the cost responsibility of general aviation (GA) users based on their minimum requirements. A <u>hypothetical</u> system meeting these minimum requirements is developed and its associated costs estimated. The results provide a lower limit to the cost responsibility of GA users.

The postulation of a system meeting the minimum GA requirements and its cost estimation were conducted under the following guidelines:

1. The analysis will identify and estimate the costs of those elements of the existing ATC system that would be essential in meeting the <u>minimum</u> requirements of the GA community. No alternative technological development will be postulated with respect to what could have been if the presence of air carrier industry had not influenced development.

2. The GA traffic is <u>not</u> assumed to grow to fill the transportation void created by the absence of air carriers in this hypothesized GA-only system. No alternative forecasts are considered to reflect the absence of air carriers.

3. Presently existing facilities will be assumed to be available at no capital cost, i.e., sunk costs will not be considered. In addition, it will be assumed that any presently existing facility not currently needed in the hypothesized GA-only system but required at a future date

will be also available at no capital cost. For example, if an existing ATC tower is not required under the postulated GA-only system today but is needed in the future due to increasing activity, it is assumed available for free when needed. This analysis assumes that the tower can be shut down and reopened when desired without any special costs or recurring upkeep cost during the shut down period. This simplifying assumption is postulated in order to achieve a lower bound on the cost responsibility of GA users by providing existing facilities in full operating condition as and when required at no cost to the hypothesized GA-only system.

2. A PERSPECTIVE OF GENERAL AVIATION USERS

General aviation users form a heterogeneous group with a wide range of aircraft types, avionics equipage and type of flight. They vary in capability from single engine piston aircraft to turboprops and turbojets. The most sophisticated GA user has avionics that are comparable to air carriers. The type and purpose of flying also varies from weekend pleasure flights (only in good weather) to the business/corporate jets and air taxi operations that use extensive system capabilities and the busiest of airports regardless of weather conditions. A recent study (Reference 2) for the FAA deals extensively with GA aircraft, owner, and utilization characteristics based on 1974 survey data. The study has shown that while 75%-80% of GA aircraft are equipped with VHF communications equipment and VOR receivers, the percentage of ILS avionics equipped aircraft is of the order of 37%. Thus, only about one third of the GA fleet is equipped for basic IFR flight and precision approach. However, usage of the ATC system under IFR weather is heavily weighted toward the more sophisticated aircraft as evidenced by the number of hours flown. Figure 2-1 (reproduced from Reference 2) shows the median hours (per aircraft) flown in local or itinerant, and VFR or IFR flight by type of aircraft.

In terms of the proportion of GA demand on the Federal system, a review of the current aviation forecasts (Reference 3) indicates that for the period of study (1977-1986) GA accounts for over 90% of aircraft contacted at FSS and 30%-40% of IFR aircraft handled at en route centers. In the terminal area, GA activity forecasts represent 85%-90% of total operations and 55%-65% of instrument operations over the same period. Almost all of local operations are GA aircraft (over 95%). About 70%-80% of itinerant operations are made by the general aviation.

To summarize, general aviation represents a wide spectrum of aircraft, avionics equipage, use and type of flights and hence the net requirements imposed on any ATC system by general aviation also cover a very wide range as reflected in the following section.

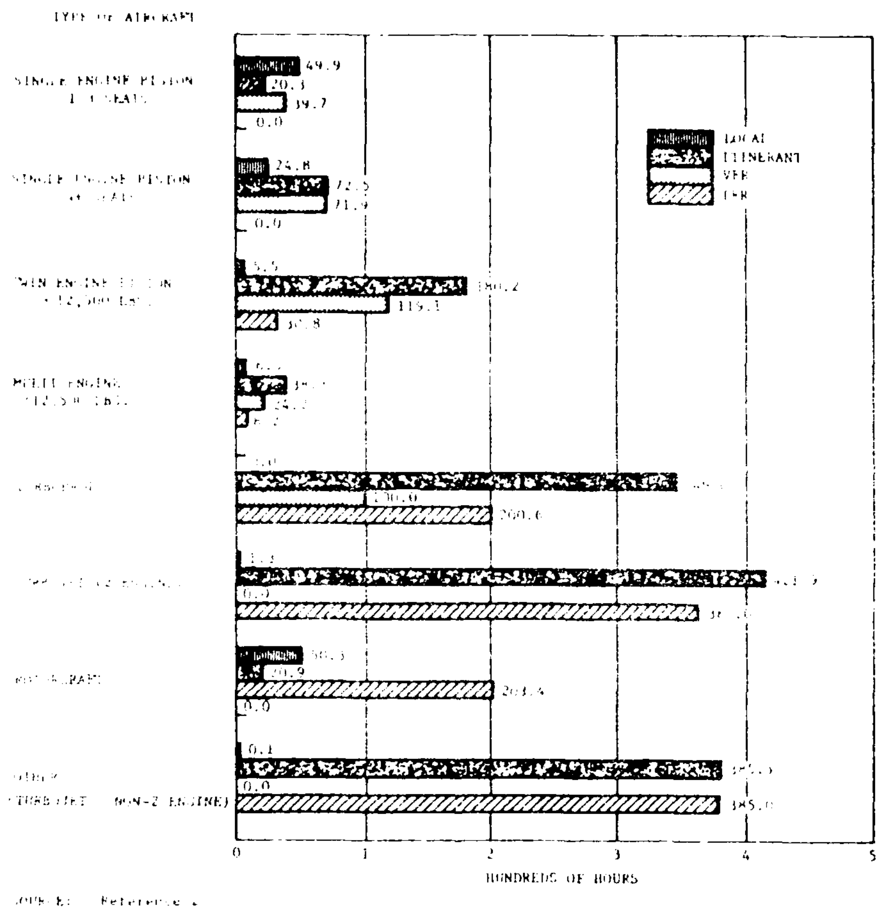

FIGURE 2-1
MEDIAN NUMBER OF HOURS FLOWN IN 1974 BY TYPE OF AIRCRAFT

3. POSTULATED GENERAL AVIATION REQUIREMENTS

In order to postulate the minimum ATC requirements of the general aviation community, it is important to recognize the different types of flights involved. Local aircraft operations originate and terminate at the same airport. They consist primarily of pleasure flying, training flights, touch-and-go and instructional flights. Almost all of the local flights are conducted during VFR weather. Consequently, local VFR operations require little, if any, ATC system interaction. Itinerant aircraft operations are interested in getting from Point A to Point B. Itinerant flights can further be divided into Visual Flight Rules (VFR) and Instrument Flight Rules (IFR) flights. VFR itinerant flights occur under good weather conditions and can be made with a minimum of equipment and ATC system interaction, while IFR flights are more sophisticated in equipage, and are capable of flying under IFR weather conditions. Air taxi, corporate and business jet and turboprop operations usually fall in the category of IFR itinerant flights. The requirements levied on the ATC system by such flights are the most stringent of the general aviation requirements.

Based on the type of flight one can postulate the GA requirements for an ATC system.

1. Local VFR Flights. Since the extent of flying is limited to a local area and good weather, for the majority of such flights the ATC system need only assign frequencies for an airport advisory system (UNICOM). At places where the operations count are high enough to meet tower establishment criteria, a VFR tower with some form of traffic control would be required. Pilots flying VFR have very little interaction with other aspects of the ATC system (navigation, approach control surveillance, landing aids, en route and FSS services).

2. Itinerant VFR Flights. Aircraft operations in this category are primarily interested in going from Point A to Point B. Although these flights are VFR flights, there is a need to have weather information along the flight path to avoid localized areas of severe weather systems. In addition, to enable aircraft to follow the desired path from A to B and to fly through unexpected bad weather, some form of low cost basic navigation aids are required. The extent of coverage of such navaids would be minimal and restricted to areas of relatively high operations densities. In the terminal area, itinerant VFR traffic has the same level of requirement for the ATC system as local VFR traffic.

3. <u>Itinerant IFR Flights</u>. These operations are the most sophisticated form of GA flying. Aircraft operating under this classification will fly in IFR weather, will file flight plans, and would require greater interaction with the ATC system. For these flights, the ATC system should provide some form of flight path monitoring and en route traffic control. Hence, a form of mini en route centers will be required. The level of services provided would be greatly reduced over today's system and the level of sophistication of the elements required would also be very low. It is assumed that there would be extensive procedural control employed. For the low traffic densities of en route GA operations, position reporting would suffice and no en route radar system would be required. The deployment of low cost basic navaids would be larger than for itinerant VFR flights to enable the unrestricted flight of itinerant IFR operations. In addition to VFR towers, there would be a series of towers with landing aids and radar approach service at selected metropolitan areas due to the desire and the need of the public to fly to and from such areas regardless of weather conditions. Because itinerant IFR traffic will crisscross the country, there will be a need for extensive weather, flight plan filing and advisory services similar to the existing FSS system.

The requirements of the three types of flights for general aviation are summarized in Table 3-1.

TABLE 3-1

GENERAL AVIATION REQUIREMENTS

ATC SERVICES	TYPE OF FLIGHT		
	LOCAL VFR	ITINERANT	
		VFR	IFR
1. ATC FACILITIES			
EN ROUTE	--	--	MINIMUM SYSTEM
TOWERS	GA CRITERIA*	GA CRITERIA*	IFR CRITERIA
FSS	--	PARTIAL	FULL
2. TRAFFIC CONTROL - COMMUNICATIONS			
AIRPORT ADV. (FREQ. ALLOCATION)	YES	YES	--
TRAFFIC CONTROL	WITH TOWERS	WITH TOWERS	WITH TOWERS AND EN ROUTE
3. TRAFFIC CONTROL - SURVEILLANCE			
POSITION REPORTS (VOICE)	WITH TOWERS	WITH TOWERS	EN ROUTE & OTHER TOWERS AT METROPOLITAN AREA TOWERS
RADAR	--	--	
4. NAVIGATION			
NAVAIDS	--	MINIMUM COVERAGE FOR HIGH DENSITY ROUTES	IFR COVERAGE (EN ROUTE/TERMINAL/NON-PREC. APPROACH
PRECISION LANDING AIDS	--	--	MINIMUM HIGH DENSITY TERMINALS (METROPOLITAN AREAS)

NOTE: ADAP COSTS TO BE TREATED SEPARATELY.

*200,000 OR MORE ANNUAL OPERATIONS

4. ELEMENTS OF THE ATC SYSTEM TO SUPPORT GENERAL AVIATION REQUIREMENTS

For purposes of identifying the elements of the existing system that would satisfy the GA requirements postulated in the preceeding section, the ATC system is divided into three categories:

1. ATC Facilities (en route, terminal, FSS)

2. Navigation System (navaids, precision landing aids)

3. Surveillance and Communications Systems (VFR voice, radars)

In the process of estimating the costs (presented in Section 5) associated with the system meeting GA requirements, it is assumed that the requirements of the most stringent user (namely, itinerant IFR traffic) will be met. For purposes of this analysis no attempt has been made to further allocate the cost of this minimum system to the different types of flight -- local or itinerant. In the course of any cost recovery phase, however, distinction among the level of requirements and system use of the different types of flight (local VFR, itinerant VFR and itinerant IFR) should be made.

4.1 ATC Facilities

General Aviation requirements for ATC services covering en route airspace would be met with 26 mini en route centers. These centers will be responsible for IFR flights and perform functions such as flight plan processing, flow control and position monitoring. The number of controllers required to handle the traffic would be substantially less. Manpower estimates are presented in Section 5.

An analysis of the latest tower operations count (FY76) indicated approximately 60 towers that meet the GA tower establishment criteria of 200,000 or more annual operations. In the GA-only scenario, these 60 towers stay on as VFR towers. To determine the number of additional more sophisticated tower requirements at metropolitan areas, the ARTS III locations were used as a starting point. Of the 68 airports, approximately 50 remained after deleting those within close proximity of each other, with low activity levels, or whose establishment was due to requirements of nearby military bases. These 50 ARTS III sites are reduced to a TRACAB level in the GA-only system. Details are presented in Appendix A.

The FSS network is overwhelmingly GA oriented and, hence, the current network and proposed modifications (as planned) are assumed to exist in a GA-only system as well.

4.2 Navigation Systems

Currently there are 906 VOR sites used as navigation aids. A previous MITRE study (Reference 4) has indicated that approximately 300 VOR sites located strategically would provide single coverage above 2000' MSL and double coverage above 6000' MSL. This calculation, however, does not account for the terrain features (mountains, obstructions, etc.) inherent in the existing locations of VOR's. It is estimated that a total of approximately 600 existing VOR sites would be required to overcome the coverage problems caused by the terrain features. To obtain conservative cost estimates however, it is assumed that 300 VOR sites would meet the minimum GA requirement of wide spread single site national coverage to moderately low altitudes. In addition, these VOR sites are to be single VOR stations with no TACAN, DME, or dual VOR installations. This reduces the cost associated with the VOR network.

In accordance with the guidelines, it is assumed that the postulated 50 metropolitan area TRACAB facilities that support the demand for IFR services would have the minimum capability of a single Category I ILS unit each. In practice, this would be below expected needs, but follows the assumption of providing a lower bound in equipment, services, and costs for the GA-only system.

4.3 Surveillance and Communications Systems

In the postulated GA system, it is assumed that no radar surveillance would be required in the en route centers. Of the terminal centers, only the 50 TRACAB towers at metropolitan areas would provide radar approach service, employing one ASR at each facility.

The voice communications consist of VHF channels only. Given the line-of-sight coverage needs for a minimum national VOR system (Reference 4), it is reasonable to assume that of the 498 RCAG sites, only 300 would be required to provide parallel communication coverage for the mini en route centers of the GA system. It is further assumed that the ATC en route channel requirements will also be reduced from 1100 VHF en route channels today (Reference 5) to 300 (one per RCAG). If the channels were reduced proportionally to the 30% of traffic represented by GA, the result would be 330 voice channels. To maintain a minimum estimate, 300 channels are assumed. For terminal control centers,

currently there are [illegible] with an estimated 4.4 average number of VHF [illegible] system, one RTR per tower is assumed [illegible], [illegible] channel requirements are reduced to one for [illegible] for each TRACAB site. Related cost [illegible] in the following section.

*Estimate is based on an approximate mix of existing towers and frequencies.

5. COST ESTIMATES*

Under the assumptions of this study, existing facilities are available to the GA-only system at no capital costs. For comparison with other elements in the "Airport and Airway System Cost Allocations: 1977-1986" (Reference 6), the development of the cost estimates are presented here in the same order as the presentation of the cost base.

5.1 Research and Development Costs

The extent of R&D in the GA-only system will be minimal at best. Relevant R&D costs are assumed to be those associated with FSS and 50% of weather related costs. FSS deals with general aviation operations, and a fraction of weather related R&D costs are expected to be spent on severe weather warning and related activities for use by the GA community. Based on FY 1977 budget, the R&D cost estimates amount to $7.0 million annually (in constant 1976 dollars) and are assumed to remain level through 1986.

5.2 Facilities and Equipment Costs

Because existing facilities are adequate to meet the requirements of the GA-only system no F&E costs associated with en route or terminal facilities would be required during the period 1977-1986. The FSS cost projections are expected to remain the same as in the existing system and are shown in Table 5-1 (Reference 7).

5.3 Operating and Maintenance Costs

The O&M costs are estimated individually for en route centers, towers, FSS and other (navaid) categories as discussed in the following subsections.

5.3.1 En Route O&M Costs

In the nonradar environment of the GA-only system, it is estimated that 1.5 controllers per shift would suffice (Reference 8). To arrive at the annual number of controllers, the following equation was used which is consistent with past studies on controller productivities (Reference 9).

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*All cost estimates in this section are in constant 1976 dollars.

TABLE 5-1

F&E COSTS OF THE FSS SYSTEM

(IN MILLIONS OF DOLLARS)

YEAR	IN CONSTANT 1976 DOLLARS	IN CURRENT DOLLARS
1977	$15.4	$16.4
1978	$ 9.0	$ 9.9
1979	$37.9	$44.0
1980	$40.4	$49.0
1981	$42.6	$54.0
1982	$44.0	$58.0
1983	$36.6	$50.0
1984	$41.1	$58.0
1985	$33.9	$50.0
1986	$19.4	$30.0

Controllers/sector = (Two shifts + 10% controllers for night shift) * (60% increase to account for vacation, sick leave, weekends, training, etc.)

*(25% overhead supervisory staff)

= (2*1.5 + 0.1*1.5) * 1.6 * 1.25

= 6.3 controllers/sector

For the number of sectors, it is assumed that of the 665 existing sectors all the high, super high, and oceanic sectors would not be required. The requirements of the GA-only system can be met through the 402 low altitude sectors (extended to cover all altitudes of controlled airspace and redesigned as needed for a non-radar system). This gives an annual controller staff estimate of 6.3 x 402 = 2533. As an external check on the plausability of this estimate as a lower bound, reducing the existing number of controllers in proportion of the GA operations resulted in a much higher estimate of approximately 3800 controllers. With an annual cost of $25,748 per controller (Reference 7), the 1977 cost would be $65.2 million for the estimated 2533 controllers.

The cost of voice communications for 300 RCAG sites is estimated based on $26,830 annual O&M cost for an average RCAG in the current system (Reference 10). This gives a total 300 site cost of $8.3 million. This cost is then reduced by 50% to account for elimination of military UHF channels and 25% to account for the reduced number of civil VHF channels; yielding a 1977 O&M estimate of $2.0 million for en route voice outlets in a GA-only system.

For the ten year study period (1977-1986), these costs (controllers and RCAG) were assumed to grow proportionally to the increases in traffic. The ten year cost estimates are presented in Section 6.

In order to estimate cost sensitivities of en route O&M, costs of additional RCAG sites and VHF frequencies were calculated. An addition of 200 RCAG sites would cost $1.3 million annually and the retention of all VHF channels would add $3.3 million to the annual O&M cost.

5.3.2 Tower O&M Costs

The controller staff estimates for the towers are based on Reference 9. An average of 13 controllers are required for VFR towers and 20 controllers for TRACABS. This gives an estimated

1780 controllers for 60 VFR towers and 50 TRACABS. The annual cost estimate is $43.3 million at $24,315/controller (Reference 7).

The voice communications cost associated with the towers is based on an annual O&M cost of $16,500/RTR with an average of 4.4 channels (Reference 10). In the GA-only system, a VFR tower would have an RTR with one channel and a TRACAB one with two channels. It is reasonable to assume linear changes in cost with the number of channels. This yields an annual O&M cost of $0.6 million for terminal voice communications in the GA-only system.

The O&M costs of an ASR and an ILS for each TRACAB would also be associated with tower operations in the GA system. The unit O&M costs for the two equipment types are $84,650 and $30,000, respectively (Reference 10). The associated annual O&M costs in the GA-only design are $5.7 million.

To be conservative in the annual estimates in Section 6, the facility cost increases projected over the 10 year analysis period were based on the slower growth rates of itinerant operations rather than the higher projected growth of instrument operations.

A sensitivity analysis of the number of TRACABS (as discussed in Appendix A) shows that 10 additional TRACABS (including RTR, ASR, ILS and controller staff) will add $6.0 million annually to the estimated system cost.

5.3.3 FSS and Other O&M Costs

FSS O&M costs are assumed to remain as projected for the current system and are presented in Section 6. The navaid O&M costs for 300 single VOR sites, based on $14,570 per site (Reference 10), are $4.4 million. The navaid costs remain constant over the years because the 300 sites were assumed to provide adequate coverage. If 600 existing sites were needed the costs would increase by $4.4 million.

5.4 Support Costs

The only support costs associated with the GA-only system are leaseline costs (I&M). These costs were estimated at $13.0 million and were assumed to remain constant over the analysis period because additional increases are expected to be relatively small. Details are given in Appendix B.

5.5 Grants-in-Aid

The grants-in-aid portion allocated for general aviation airports were assumed to exist in the GA-only system and are presented in Section 6.

6. SUMMARY

The estimated annual costs for an ATC system meeting minimum GA requirements are summarized in Table 6-1 in constant 1976 dollars. Table 6-2 provides the same estimates in current dollars. The costs estimated grow from $331 million in 1977 to $400 million by 1986 in constant 1976 dollars, and $357 million in 1977 to $703 million in 1986 in current dollars.

The cost estimates provide a lower bound on a GA-only system. In certain areas, the estimates have been extremely conservative. The cost sensitivity of the minimum system to questions of coverage and demands for service is rather small. By way of sensitivity analysis, the following estimates are provided in constant 1976 dollars:

10 additional TRACABS (including RTR, ASR, ILS and controller staff)	$6.0 million/year O&M
300 additional VOR sites (to provide coverage based on existing locations)	$4.4 million/year O&M
200 additional RCAG sites (to provide coverage based on locations)	$1.3 million/year O&M
Additional VHF frequencies for RCAG	$3.3 million/year O&M
	$15.0 million/year O&M

Thus, a more operationally feasible estimate based on the service needs demonstrated by the existing ATC system would add $15 million/year (4.5%) in constant 1976 dollars to the estimates of the GA-only system.

The cost estimates developed here represent an ATC system that would meet the requirements of all types of GA flights. Care should be taken in any cost recovery analysis to differentiate in cost responsibility between the various classes of GA users (pleasure, business/corporate, agricultural, instructional, air taxi) and between the different types of GA flights (local VFR, itinerant VFR and itinerant IFR).

TABLE 6-1

SUMMARY OF COST ESTIMATES IN CONSTANT 1976 DOLLARS
(IN MILLIONS)

YEAR → / ↓ ELEMENT	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
R&D	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
F&E	15.4	9.0	37.9	40.4	42.6	44.0	36.6	41.1	33.9	19.4
FSS	15.4	9.0	37.9	40.4	42.6	44.0	36.6	41.1	33.9	19.4
O&M	228.4	238.5	246.3	255.0	266.2	275.9	281.0	286.5	291.2	295.1
CENTERS	67.2	74.2	79.7	87.5	96.9	103.9	107.8	113.3	118.0	121.9
TOWERS	49.6	52.7	55.0	58.1	62.0	66.9	70.2	72.3	74.5	76.6
FSS	107.2	107.2	107.2	105.0	102.9	100.7	98.6	96.5	94.3	92.2
OTHER	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4
SUPPORT	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0
I&M	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0
GRANTS-IN-AID	67.4	67.9	67.5	66.8	66.5	66.6	66.9	67.2	66.5	66.2
TOTAL	331.2	335.4	371.7	382.2	395.3	406.5	404.5	414.8	411.6	400.7

TABLE 6-2

SUMMARY OF COST ESTIMATES IN CURRENT DOLLARS
(IN MILLIONS)

YEAR → / ↓ ELEMENT	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
R&D	7.6	8.0	8.5	8.9	9.5	10.0	10.5	11.1	11.7	12.3
F&E	16.[illegible]	9.9	44.0	49.0	54.0	58.0	50.0	58.0	50.0	30.[illegible]
FSS	16.4	9.9	44.0	49.0	54.0	58.0	50.0	58.0	50.0	30.[illegible]
O&M	246.[illegible]	272.8	297.8	3[illegible].6	359.6	393.6	422.3	453.8	487.5	[illegible]
CENTERS	72.4	84.9	96.4	111.7	130.9	148.2	162.0	179.5	197.5	214.9
TOWERS	53.5	60.2	66.5	74.2	83.8	95.4	105.5	114.5	124.7	135.0
FSS	[illegible]	121.6	129.6	134.1	139.0	143.7	148.2	152.8	157.9	[illegible]
OTHER	4.7	5.0	5.3	5.6	5.9	6.3	6.6	7.0	7.4	7.8
SUPPORT	14.0	14.9	15.7	16.6	17.6	18.5	19.5	20.6	21.8	22.9
I&M	14.0	14.9	15.7	16.6	17.6	18.5	19.5	20.6	21.8	22.9
GRANTS-IN-AID	71.6	77.1	82.1	87.1	92.1	97.2	102.2	107.2	112.2	117.[illegible]
TOTAL	355.7	382.7	448.1	487.2	532.8	577.3	604.5	650.7	683.2	[illegible]

APPENDIX A

POSTULATED [illegible] REQUIREMENTS

In estimating the [illegible] within the existing ATC system, it [illegible] postulate general aviation requirements. One component of the general aviation requirement is the need for basic terminal control services. Within this service category, there is a need for both VFR towers and IFR facilities with a [illegible] capability.

The number of VFR towers can be estimated by identifying those points, other than ARTS [illegible], whose current general aviation count meets the [illegible] criterion of 200,000 annual GA operations. [illegible] now meet this standard.

Existing ARTS III [illegible] starting point to determine the general [illegible] locations with higher traffic and population [illegible] there are a total of 68 ARTS III type [illegible] the United States. Because construction of these [illegible] predicated on overall traffic levels and other [illegible], certain modifications must be made to the [illegible] order to match anticipated general aviation needs. Military and governmental considerations appear to have led to the establishment of five ARTS facilities* that thus would likely not be needed in the general aviation system.

Additionally, there are seven [illegible] towers* whose close proximity to other [illegible] facilities makes their retention in the postulated system questionable. In attempting to identify these locations, metropolitan areas where there are three or more facilities within a 50 mile radius were considered. This leaves a general aviation system consisting of approximately 56 ARTS III locations where a less sophisticated radar approach tower (TRACAB) would be required.

Evaluation of further reducing terminal radar service locations for a general aviation system is a more subjective endeavor. The geographic distribution of the remaining 56 ARTS III locations was compared to current general aviation operations. This comparison identified certain locations that are geographically isolated and whose operational counts are so low as to not warrant a tower facility if supported by GA activity and needs alone.** There are seven of these ARTS locations.* This leaves

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*See Table A-1 for a listing of these towers.

**Less than 150,000 GA operations within a 50 mile radius of the ARTS site.

TABLE A-1

ARTS III LOCATIONS IN THE GENERAL AVIATION SYSTEM

TOTAL ARTS III TYPE LOCATIONS		68
Eliminate Due To:		
Military and Governmental Considerations		
Shreveport		
Oklahoma City		
NAFEC (2)		
Orlando	(5)	63
Close Proximity to Other Facilities		
Newark		
Dulles		
Long Beach		
Kennedy		
Baltimore		
Burbank		
Oakland	(7)	
GENERAL AVIATION REQUIREMENT		56
Eliminate Due To:		
Low Level of Operations		
Louisville		
Albany		
Sacramento		
Jacksonville		
Hartford		
New Orleans		
Buffalo	(7)	
MINIMUM GENERAL AVIATION REQUIREMENT		49

approximately 50 sites for TRACAB facilities in the minimum system.

The deletion criteria employed attempted to minimize the amount of IFR delay and inconvenience that might occur in the GA-only system. Consideration was also given to those instrument operations that might transfer to the TRACAB (present ARTS III) locations in the absence of their current day high air carrier activity levels. It is expected that in many cases, sufficient general aviation demand would shift from the postulated untowered airports to the towered facilities to make up the deficiencies in establishment criteria. The concentration of facilities in major metropolitan areas is displayed in Table A-2.

In summary, it is estimated that a general aviation system would be comprised of approximately 50 to 60 TRACAB facilities and 60 VFR towers.

TABLE A-2

ARTS III FACILITIES IN MAJOR METROPOLITAN AREAS

METROPOLITAN AREAS	PRESENT ARTS III SITES		POSTULATED SYSTEM		
	EXISTING	ELIMINATED DUE TO CLOSE PROXIMITY TO OTHER FACILITIES	IFR TOWERS (TRACAB)	VFR TOWERED (GA OPERATIONS OVER 200,000)	ADDITIONAL GA AIRPORTS WITHIN 50 MILE RADIUS (100,000-200,000 OPS)
NEW YORK	3	2	1	5	-
WASHINGTON	3	2	1	-	1
MIAMI	1	-	1	3	2
BOSTON	1	-	1	3	1
CHICAGO	1	-	1	2	2
SAN FRANCISCO	2	1	1	7	1
LOS ANGELES	4	2	2	7	2
DALLAS	1	-	1	2	2

APPENDIX B

ESTIMATE OF LEASELINE COSTS

The estimate of leaseline costs were arrived at through a functional analysis of the requirements of the GA-only system. Table B-1 presents the cost estimates in 1976 dollars based on Reference 11. For some elements, engineering estimates are made based on existing or historical figures.

TABLE B-1

ESTIMATE OF LEASELINE COSTS

		CONSTANT 1976 DOLLARS
FLIGHT SERVICE STATIONS		
	20 circuits/stations	
	*140 miles/circuit	
	*292 stations	
	*0.54 $/mile/month	
	* 12 month/year	
	$5.4 million/year	$5.4 million
FLIGHT ASSISTANCE SERVICE		
	$0.84 million in 1972 dollars	$1.2 million
FOREIGN EXCHANGE		
	$0.23 million in 1972 dollars	$0.3 million
INTERCENTER NONRADAR		
	$1.0 million	
CENTER INTRA-AREA NONRADAR		
	$2.3 million	
FACILITY SWITCHING & KEY EQUIPMENT		
	$18.1 million	
TOWER EN ROUTE		
	$0.5 million	
	$21.9 million in 1972 dollars	
ESTIMATED 20% FOR GA-ONLY SYSTEM	$4.4 million in 1972 dollars	$6.1 million
	TOTAL (in 1976 dollars)	$13.0 million

APPENDIX C

GLOSSARY

A.C./ AC	AIR CARRIER
A-P/ AP/ ARPT	AIRPORT
AAT	FAA AIR TRAFFIC SERVICE
ADAP	AIRPORT DEVELOPMENT AID PROGRAM
ADM/ ADMIN	ADMINISTRATION
ADV	ADVISORY
AFTN	AERONAUTICAL FIXED TELECOMMUNICATIONS NETWORK
AOPA	AIRCRAFT OWNERS AND PILOTS ASSOCIATION
ARSR	AIR ROUTE SURVEILLANCE RADAR
ARTCC	AIR ROUTE TRAFFIC CONTROL CENTER
ARTS	AUTOMATED RADAR TRAFFIC CONTROL SYSTEM
ASC	ADMINISTRATIVE SCIENCES CORPORATION
ASR	AIRPORT SURVEILLANCE RADAR
ATC	AIR TRAFFIC CONTROL
AVP	FAA OFFICE OF AVIATION POLICY
C-AP	CAPITOL AIRPORTS
CAB	CIVIL AERONAUTICS BOARD (SEE ALSO TRACAB)
CAP	CAPITOL
CENT	CENTRALIZED
CONUS	CONTINENTAL UNITED STATES
CSC	COMPUTER SCIENCES CORPORATION
CTR	CENTER (EN ROUTE)
DCA	WASHINGTON NATIONAL AIRPORT
DCS	DATA COMMUNICATIONS SYSTEM
DEV	DEVELOPMENT
DIR	DIRECTION
DME	DISTANCE MEASURING EQUIPMENT
DOD	DEPARTMENT OF DEFENSE
DOT	DEPARTMENT OF TRANSPORTATION
E&D	ENGINEERING AND DEVELOPMENT
F ST/ FLT STDS	FLIGHT STANDARDS
F&E	FACILITIES AND EQUIPMENT
F,E&D	FACILITIES, ENGINEERING AND DEVELOPMENT
FAA	FEDERAL AVIATION ADMINISTRATION
FAC	FACILITY
FREQ	FREQUENCY
FSS	FLIGHT SERVICE STATIONS
FY	FISCAL YEAR
G.A./ GA	GENERAL AVIATION
GAMA	GENERAL AVIATION MANUFACTURERS ASSOCIATION

GLOSSARY (Contd.)

GOVT	GOVERNMENT
GRANTS	GRANTS-IN-AID
I&M/ IN & MAT	INSTALLATION AND MATERIAL
IAD	DULLES INTERNATIONAL AIRPORT
IFR	INSTRUMENT FLIGHT RULES
ILS	INSTRUMENT LANDING SYSTEM
JFK	JOHN F. KENNEDY INTERNATIONAL AIRPORT
LRIC	LONG RUN INCREMENTAL COST
LRMC	LONG RUN MARGINAL COST
MAINT	MAINTENANCE
MDW	CHICAGO MIDWAY AIRPORT
MED	MEDICAL (PROGRAMS)
MIL	MILITARY
MSL	MEAN SEA LEVEL
NAFEC	NATIONAL AVIATION FACILITIES EXPERIMENTAL CENTER
NAS	NATIONAL AIRSPACE SYSTEM
NASA	NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
NASP	NATIONAL AVIATION SYSTEM PLAN
NATL/ NTL	NATIONAL
NAVAIDS	NAVIGATION AIDS
NBAA	NATIONAL BUSINESS AIRCRAFT ASSOCIATION
NOAA	NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NWS	NATIONAL WEATHER SERVICE
O&M	OPERATIONS AND MAINTENANCE
OPS	OPERATIONS
ORD	CHICAGO O'HARE INTERNATIONAL AIRPORT
OST	OFFICE OF THE SECRETARY OF TRANSPORTATION
PATWAS	PILOT'S AUTOMATIC TELEPHONE WEATHER ANSWERING SERVICE
PGP	AIRPORT PLANNING GRANT PROGRAM
R&D	RESEARCH AND DEVELOPMENT
R&M	RELOCATION AND MODIFICATION
R,E&D	RESEARCH, ENGINEERING AND DEVELOPMENT
RCAG	REMOTE COMMUNICATIONS, AIR TO GROUND
RCS	RADIO COMMUNICATIONS SYSTEM
RTR	REMOTE TRANSMITTER/RECEIVER
S.E.E.	STANDARD ESTIMATE OF ERROR

APPENDIX C

GLOSSARY (Contd.)

S&S	STAFF AND SUPPORT
SRMC	SHORT RUN MARGINAL COSTS
SUP	SUPPORT
TACAN	TACTICAL AIR NAVIGATION AID
TCS	TECHNICAL CONTROL SERVICE
TR	TRAFFIC
TRACAB	TERMINAL RADAR CONTROL FACILITY COLOCATED WITH A CONTROL TOWER
TRACON	TERMINAL RADAR CONTROL FACILITY
TRN	TRAINING
TWEB	TRANSCRIBED WEATHER BROADCASTS
TWR	TOWER (TERMINAL)
U.S.	UNITED STATES
UG3RD	UPGRADED THIRD GENERATION
UHF	ULTRA HIGH FREQUENCY
UNICOM	AERONAUTICAL ADVISORY STATION
VCS	VOICE COMMUNICATIONS SYSTEM
VFR	VISUAL FLIGHT RULES
VHF	VERY HIGH FREQUENCY
VOR	VHF OMNI-RANGE (NAVIGATION AID)
VORTAC	COLOCATED VOR AND TACAN

APPENDIX D

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